REMARKS

Applicants thank the Examiner for the very thorough consideration given the present application. Claims 1 and 3-11 are currently pending in this application. Claim 2 has been cancelled. Claims 3-9 have been withdrawn from further consideration by the Examiner. No new matter has been added by way of the present amendment. For instance, claim 1 has been amended to incorporate the limitations of previously presented claim 2. Newly added claim 11 is supported by the Specification at page 4, lines 30-35 and page 5, lines 1-9. Accordingly, no new matter has been added.

In view of the amendments and remarks herein, Applicants respectfully request that the Examiner withdraw all outstanding rejections and allow the currently pending claims.

Election/Restrictions

The Examiner has set forth a restriction requirement with regard to claims 1-10.

During a telephone conversation with the Examiner on April 12, 2007, a provisional election was made to prosecute the invention of Group I, claims 1, 2 and 10. Applicants hereby affirm this election.

Applicants reserve the right to file a divisional application directed to the nonelected claims at a later date.

Issues Under 35 U.S.C. § 102/103(a)

JP 5-238830

Claims 1 and 2 stand rejected under 35 U.S.C. §102(b) as anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over JP 5-238830 (hereinafter JP '830). Applicants respectfully traverse.

The Examiner asserts that JP '830 discloses a sintered aluminum nitride body having a pore size less than 1 micron and a grain size less than 1 micron. As to the claimed properties of the sintered body of the present invention, the Examiner does not address the pore density, pore area ratio and Vickers' hardness. The Examiner asserts that a body having a grain size less than 1 micron (such as that disclosed by JP '830) "would be expected to have such a distribution absent tangible evidence to the contrary".

Applicants respectfully submit that the Examiner has failed to establish a *prima facie* case of anticipation. For anticipation under 35 U.S.C.§102, the reference must teach each and every aspect of the claimed invention either explicitly or impliedly. Any feature not directly taught must be inherently present. The fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic. *In re Rijckaert*, 9 F.3d 1531, 28 USPQ2d 1955 (Fed. Cir. 1993). To establish inherency, the extrinsic evidence "must make clear that the missing descriptive matter is necessarily present". *In re Robertson*, 169 F.3d 743, 49 USPQ2d 1949 (Fed. Cir. 1999). The mere fact that a certain thing may result from a given set of circumstances is not sufficient. *Id.*

Furthermore, Applicants respectfully submit that the Examiner has failed to establish a *prima facie* case of obviousness. To establish a *prima facie* case of obviousness, the prior art

reference (or references when combined) must teach or suggest all the claim limitations. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). Furthermore, there must be a reason why one of ordinary skill in the art would modify the reference or combine reference teachings to obtain the invention. A patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art. *KSR Int'l Co. v Teleflex Inc.*, 82 USPQ2d 1385 (U.S. 2007). There must be a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does. *Id.* The Supreme Court of the United States has recently held that the "teaching, suggestion, motivation test" is a valid test for obviousness, albeit one which cannot be too rigidly applied. *Id.* Rejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness. *Id.*

The present invention is directed to a novel aluminum sintered body comprising crystal grains of an average grain size (D_{50}) of 0.1 to 2.5 μm, and having a pore area ratio equal to or less than 1×10^{-7}, a pore density (of pores having diameters greater than or equal to 1μm) equal to or less than 0.05 pores/mm^2, and a Vickers' hardness in a range of 14 to 17 GPa. Furthermore, the grain distribution of the crystal grains of the novel aluminum nitride sintered body of the present invention is such that a difference between the cumulative 90% grain size (D_{90}) and the cumulative 10% grain size (D_{10}) is not larger than 1.5 μm. JP '830 fails to teach or suggest these limitations.

As specified in the presently pending claims, the aluminum nitride sintered body of the present invention comprises crystal grains having a particular average gain size and a sharp grain

size distribution. Being constituted by such crystal grains, the aluminum nitride sintered body has a small pore area ratio and a small pore density and, therefore, exhibits a very high Vickers' hardness (14 to 17 GPa). Due to the above properties, the aluminum nitride sintered body of the present invention can be subjected to "super-mirror machining" to form a mirror surface having a maximum roughness of not larger than 0.04 μm and can, therefore, be used for such applications as circuit boards on which fine wirings are formed.

The aluminum nitride sintered body of the present invention, comprising crystal grains having such a sharp grain size distribution and small average grain size (D_{50} of 1-2 μm) is obtained only through sintering by pulse current heating, and is not obtained by any other method. As discussed in Applicants' Specification, conventional sintering methods allow crystal grains to grow conspicuously even when using an aluminum nitride powder having a small grain size as a starting material. As a result, the crystal grain size exceeds 2.5 μm and often exceeds 5 μm. Even when the pore density is small, the diameter of the pores increases as the crystal grains grow and the pore area ratio usually exceeds 5×10^{-7} on the cut surface of the aluminum nitride sintered body (see Applicants' Specification at page 8, lines 3-17). JP '830 does not teach or suggest the production of an aluminum nitride sintered body by pulse current heating.

JP '830 is directed to an aluminum nitride sintered body having a maximum pore diameter of not larger than 1 μm. JP '830 discloses the production of a sintered body by firing an aluminum nitride powder having an average grain size of not larger than 1.5 μm (see Examples of JP '830). The Examiner appears to take the position that the sintered body of JP '380 inherently possesses the properties of the presently claimed sintered body, as it is produced

by using a powder having a small average grain size and its maximum pore diameter is not larger than 1 μm.

Initially, Applicants submit that the use of aluminum nitride powder having a small average grain size does not necessarily mean that the crystal grains become small in size. The growth of crystals is a function of the sintering temperature and the sintering time.

As discussed above, the aluminum nitride sintered body of the present invention exhibits the above-mentioned properties because it is produced by a pulse current method wherein heat is produced by flowing an electrical current. The aluminum nitride powder of the present invention is sintered while being pressed by feeding a pulse current at a temperature of 1500°C to 1800°C, so as to produce an aluminum nitride sintered product having the above-mentioned properties (see Applicants' Specification at page 10, lines 21-27). This method forms a local neck junction among the grains. The neck junction grows into a stable coupling, and sintering is completed in a very short period of time (e.g., less than 30 minutes), effectively suppressing the growth of crystal grains. As a result, the novel aluminum nitride sintered body of the present invention is obtained, exhibiting a small average grain size, sharp grain size distribution, high density, and fewer pores.

In stark contrast, JP '830 discloses the production of an aluminum nitride sintered body produced by heating in a firing furnace. JP '830 does not teach or suggest sintering by pulse current. Furthermore, JP '830 discloses sintering over an extended period of time (4 hours) and at very high temperatures (1815°C) (see JP '830 at [0034]-[0036]). The aluminum nitride sintered body disclosed by JP '830 has not been suppressed for the growth of crystal grains. Therefore, even if the starting powder has an average grain size of not larger than 1.5 μm, the

average grain size of the crystal grains forming the sintered body will not be in a range of 0.1 to 2.5 µm, as presently claimed.

Furthermore, the grain size distribution in the aluminum nitride sintered body disclosed by JP '830 is very broad. Even if the maximum pore diameter was not larger than 1 µm, the pore density would be so high that the high hardness (14 to 17 Gpa) exhibited by the product of the present invention could not be obtained. Furthermore, the aluminum nitride sintered body disclosed by JP '830 does not have mirror machinability, unlike that of the present invention.

The Examiner's attention is directed to Figure 1 of JP '830, which shows a maximum diameter Dp of 1 µm or less in the grain boundary phase of the aluminum nitride sintered body. Based on the maximum diameter Dp, the aluminum nitride crystal gains would have a grain size considerably larger than 2.5 µm. Furthermore, the reference discloses neither the hardness nor the mirror machinability of the aluminum nitride sintered body of the present invention.

For purposes of illustration and not limitation, the Examiner's attention is directed to Applicants' Comparative Examples 5 and 6. These Comparative Examples use a fine aluminum nitride powder having an average grain size of 2.5 µm as the starting powder without. However, sintering is not performed by the pulse current method. In the Examples, the sintering temperature is 1800°C and the sintering time is 5 hours, conditions which are nearly identical to those disclosed by JP '830 (1815°C, 4 hours). In these Comparative Examples, the average grain size, pore density and pore area ratio are considerably larger than those of the presently claimed sintered body, and the grain size distribution is very broad. As a result, the hardness is low and the mirror machinability is inferior to that of the present invention. (see Applicants' Examples 1-14). Applicants respectfully submit that the properties of the aluminum nitride sintered body

disclosed by JP '830 are comparable to those of the sintered body of Applicants' Comparative Examples 5 and 6. Evidently, the aluminum nitride sintered body disclosed by JP '830 is different from the aluminum nitride sintered body of the present invention.

Clearly, JP '830 fails to explicitly or implicitly teach each and every aspect of the claimed invention, and thus fails to anticipate the same. Furthermore, one skilled in the art would not be motivated to modify the teachings of this reference in an attempt to arrive at the present invention, absent impermissible hindsight gleaned from Applicants' disclosure.

Accordingly, reconsideration and withdrawal of this rejection are respectfully requested.

Natsuhara '275

Claims 1 and 2 stand rejected under 35 U.S.C. §102(b) as anticipated by or, in the alternative, under 35 U.S.C. §103(a) as being unpatentable over Natsuhara et al. (U.S. 6,294,275) (hereinafter Natsuhara '275). Applicants respectfully traverse.

Applicants initially note that the Examiner asserts that claim 3 is rejected over Natsuhara '275. However, claim 3 is directed to a non-elected invention. Applicants assume that the inclusion of claim 3 is a typographical error.

Natsuhara '275 discloses an aluminum nitride sintered body comprising crystal grains having an average grain size of not larger than 2 μm. However, Natsuhara '275 does not teach or suggest a pore area ratio not larger than 1×10^{-7}, pore density of not larger than 0.05 pores/mm^2 of pores having diameters of not smaller than 1μm, or a Vickers' hardness in a range of 14 to 17 GPa. Furthermore, Natsuhara '275 fails to teach or suggest a grain distribution of the

crystal grains such that a difference between the cumulative 90% grain size (D_{90}) and the cumulative 10% grain size (D_{10}) is not larger than 1.5 μm.

As previously discussed, the aluminum nitride sintered body of the present invention comprising crystal grains having a sharp grain size distribution and a very small average grain size is obtained only through sintering by pulse current heating, and is not obtained by any other method. As was the case with JP '830 (discussed above), Natsuhara '275 does not teach or suggest sintering by a pulse current method. Based on the sintering time described in the Examples of Natsuhara '275, it is clear that sintering in Natsuhara '275 is effected by heating a firing furnace.

Example 1 of Natsuhara '275 discloses the use of a mixed powder of aluminum nitride powders of fine grain sizes produced by different production methods, at a temperature of 1650°C for 10 hours. As previously discussed, sintering would result in crystal grains growing conspicuously and a very broad grain size distribution (difference between D_{90} and D_{10}), despite the use of crystal grains having a small average grain size.

The sintering conditions disclosed by Natsuhara '275 would result in a grain size distribution similar to that of Applicants' Comparative Example 5, discussed above, wherein the difference between D_{90} and D_{10} is not smaller than 3.5 μm. The crystal grains of the sintered body of Natsuhara '275 may have a fine average grain size in the same range as those of the present invention, but have a very large pore density and a very large pore area ratio. Therefore, the sintered body disclosed by Natsuhara '275 will not exhibit as high a hardness as that of the present invention, and will exhibit considerably inferior mirror machinability.

Clearly, Natsuhara '275 fails to explicitly or implicitly teach each and every aspect of the claimed invention, and thus fails to anticipate the same. Furthermore, one skilled in the art would not be motivated to modify the teachings of this reference in an attempt to arrive at the present invention, absent impermissible hindsight gleaned from Applicants' disclosure.

Reconsideration and withdrawal of this rejection are thus respectfully requested.

Katsuda '576

Claims 1, 2 and 10 stand rejected under 35 U.S.C. §102(a or e) as anticipated by or, in the alternative, under 35 U.S.C. §103(a) as being unpatentable over Katsuda et al. (U.S. 6,800,576) (hereinafter Katsuda '576). Applicants respectfully traverse.

Katsuda '576 discloses an aluminum nitride sintered body containing a small amount of aluminum oxide component. The sintered body has an average grain size of aluminum nitride crystal grains of not larger than 3 μm and a micro Vickers' hardness of not smaller than 1100 degrees (not smaller than 10 Gpa). The reference discloses sintering by hot pressing, at sintering temperatures of 1750 to 1800°C and a sintering time of 2 hours (see Examples of Katsuda '576).

As previously discussed, the aluminum nitride sintered body of the present invention comprising crystal grains having a sharp grain size distribution and a very small average grain size is obtained only through sintering by pulse current heating, and is not obtained by any other method. Katsuda '576 does not teach or suggest sintering by a pulse current method. As is clear from the disclosure of Katsuda '576, the sintering time is considerably longer than that of the present invention, and the growth of crystal grains is not effectively suppressed (see Examples of Katsuda '576).

Katsuda's Examples disclose the use of an aluminum nitride powder having an average grain size of 1 to 1.5 μm (see Katsuda '576 at column 5, line 21). However, the obtained sintered body has an average grain size of aluminum nitride crystal grains of 1.9 to 2.9 μm. Furthermore, the grain size distribution is broader than that of the present invention.

The Examiner's attention is directed to Table 1 of Katsuda '576. The data in Table 1 shows sintered bodies having an open porosity smaller than 0.01%. Clearly, the sintered body that is obtained by the process of Katsuda '576 has a considerably higher relative density. However, Katsuda '576 does not disclose the pore density or pore area ratio of the sintered bodies. Therefore, this data cannot be directly compared with that of the present invention. Furthermore, the surface roughness of the sintered body that is mirror machined has not been represented by a maximum roughness. Therefore, the mirror machinability cannot be directly compared with that of the present invention either.

As discussed above, the crystal grains of Katsuda '576 grow during sintering and the grain size distribution becomes considerably broad. Accordingly, one skilled in the art would conclude that the pore density and the pore area ratio of the sintered body of Katsuda '576 are greater than those of the sintered body of the present invention and, therefore, the mirror machinability would be considerably inferior than that of the present invention. This conclusion is further supported by the micro Vickers' hardness of the sintered bodies disclosed by Katsuda '576. The micro Vickers' hardnesses of the sintered bodies obtained in the Examples of Katsuda '576 are in a range of 11.1 to 12.21 GPa, which is lower than the Vickers' hardnesses exhibited by the aluminum nitride sintered body of the present invention (14 to 17 Gpa). Based on the micro Vickers' hardness, it is clear that the sintered body disclosed by Katsuda '576 has a broad

grain size distribution and, therefore, has a pore density and a pore area ratio inferior to those of the present invention. Accordingly, the aluminum nitride sintered body of the present invention has superior mirror machinability (i.e., super-mirror machinability).

Clearly, Katsuda '576 fails to explicitly or implicitly teach each and every aspect of the claimed invention, and thus fails to anticipate the same. Furthermore, one skilled in the art would not be motivated to modify the teachings of this reference in an attempt to arrive at the present invention, absent impermissible hindsight gleaned from Applicants' disclosure.

Applicants respectfully request reconsideration and withdrawal of this rejection.

Conclusion

All of the stated grounds of rejection have been properly traversed, accommodated, or rendered moot. Applicants therefore respectfully request that the Examiner reconsider all presently outstanding rejections and objections and that they be withdrawn. It is believed that a full and complete response has been made to the outstanding Office Action and, as such, the present application is in condition for allowance.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Marc S. Weiner, Reg. No. 32,181 at the telephone number of the undersigned below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37.C.F.R. §§1.16 or 1.14; particularly, extension of time fees.

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Respectfully submitted,

By________________________

Marc S. Weiner
Registration No.: 32,181
BIRCH, STEWART, KOLASCH & BIRCH, LLP
8110 Gatehouse Road
Suite 100 East
P.O. Box 747
Falls Church, Virginia 22040-0747
(703) 205-8000
Attorney for Applicant

MSW/VP/sh